

Anais da



Academia Brasileira de Ciências

Vol. 68, Supl. 1, 1996

Comissão Editorial

Affonso Guidão Gomes (Editor Chefe)

—CIÊNCIAS FÍSICAS

Cesar Camacho Manco

—CIÊNCIAS MATEMÁTICAS

Antonio de Freitas Pacheco

—CIÊNCIAS FÍSICAS

Fernando Galembeck

—CIÊNCIAS QUÍMICAS

Diógenes de Almeida Campos

—CIÊNCIAS DA TERRA

Lewis Joel Greene

—CIÊNCIAS BIOLÓGICAS

Anais da



Academia Brasileira de Ciências

Vol. 68, Supl. 1, 1996

Regional Conference on
Global Change,
São Paulo
December 4—6, 1995

Executive Committee

Ivano G.R. Gutz
Aldo C. Rebouças
Afrânio R. Mesquita
Benedito P.F. Braga Jr.
Bohdan Matvienko
Eurico C. Oliveira Fo.
Jurandyr L.S. Ross
Kenitiro Suguio
Paulo Artaxo
Pedro L.S. Dias

Science Committee

Eduardo M. Krieger
Haroldo Mattos de Lemos
Igor I.G. Pacca
José Galizia Tundisi
Luiz Bevilacqua
Márcio Nogueira Barbosa
Umberto G. Cordani

Probable Drier Holocene Climate Evidenced by Charcoal Bearing Middle São Francisco River Paleodunes, State of Bahia, Brazil

ALCINA M. F. BARRETO¹, LUIZ C. R. PESSENDA² and KENITIRO SUGUIO¹

¹Instituto de Geociências, USP, C. P. 11.348 – 05422-970 São Paulo, SP

²CENA/USP, C. P. 96 – Av. Centenário, 303, 13400-970 Piracicaba, SP

Manuscript received on March, 1996; accepted for publication on October 30, 1996

ABSTRACT

Charcoal in soils and lacustrine deposits, as evidence for probable Holocene climatic oscillations, have been reported by previous authors in different areas of Brazil. However, this is the first notice on their occurrence in eolian deposits of semiarid northeastern Brazil.

Small fragments (few millimeters to about 1.5 cm) of charcoal, scattered within eolian sands, mostly distributed from 60 to 90 cm of depth, have been recorded. Twelve dated charcoal samples have yielded redocarbon ages ranging from about 850 to 4,800 years BP.

Although one cannot discard the possibility of an anthropogenic origin for these charcoal fragments, it is impressive that the ¹⁴C dates obtained are comparable to some dated drier phases during the Holocene of some areas of Brazil.

Dating of a charcoal fragment from a sample collected at 90-150 cm depth interval suggest that the climate prior to 4,800 years BP was dry and eolian activity was low. Increase in frequency of charcoal fragments in the sands was observed between 1,700 and 1,220 years BP. The last occurrence of fire in the surrounding vegetation is reported at 850 years B, which could suggest that "caatinga" vegetation was stabilized only after this epoch.

Key words: paleoclimate, paleodunes, Quaternary, Bahia.

INTRODUCTION

Along the middle São Francisco river, State of Bahia, between the towns of Barra and Pilão Arcado, a large fossil dunefield covers an area of about 7,000 km² (Fig. 1). The present climate of the dunefield region is semi-arid with annual rainfall ranging from 400 to 800 mm. Fluctuations in seasonal wind regimes are controlled by the Atlantic Equatorial and Atlantic Tropical (trade winds) air masses during the winter, and by the Continental Equatorial air mass during the summer. Pres-

ently, with the exception of a very few sites, the winds are not strong enough to cause migration of the dunes. The São Francisco river dunefield is dominated by extensive parabolic compound dunes (draas), presently covered by semi-arid caatinga vegetation. These dunes exhibit a typically eolian morphology, partially obliterated by erosional and pedogenetic processes (Barreto & Suguio, 1992). According to Thomas & Shaw (1991), presently active parabolic dunes are more typical of areas with annual rainfall ranging between 200 and 275 mm. This suggests that the dunes here studied are not in equilibrium with the present climate.

Correspondence to: Kenitiro Suguio

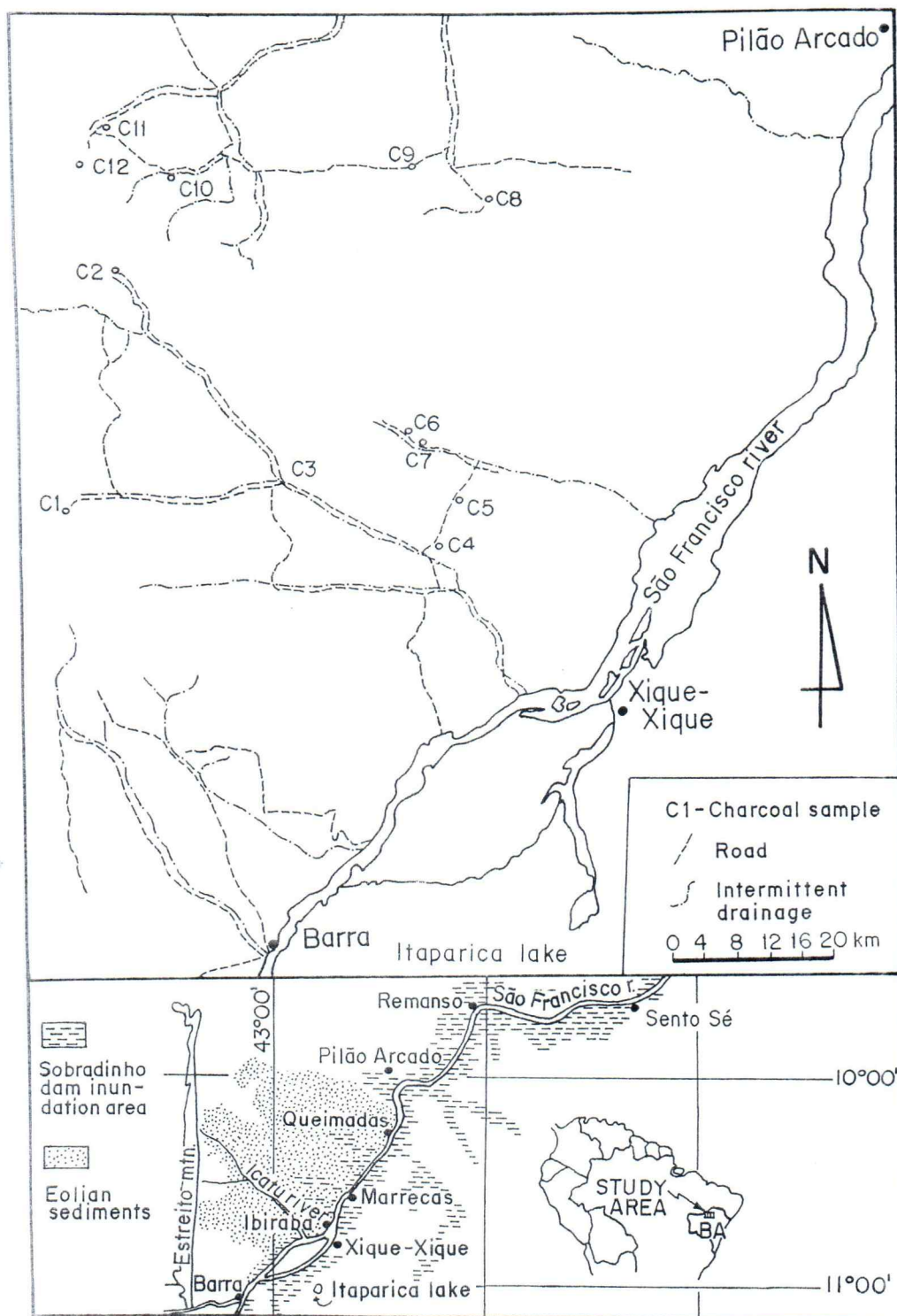


Fig. 1 — Location map of the study area, indicating the samples dated by radiocarbon analysis.

PRESENCE OF CHARCOAL FRAGMENTS

Somewhat abundant charcoal fragments occur in soils (Soubies, 1980; Sanford *et al.*, 1985; Servant *et al.*, 1989; Vernet *et al.*, 1994; Scheel *et al.*, 1995); in lacustrine (Absy *et al.*, 1989; Cordeiro, 1995), and in peat deposits (Barberi-Ribeiro, 1994) in several regions of Brazil. In general, they have been attributed to forest fires of anthropogenic or natural origins.

Occurrence of charcoal fragments in dune sands, and in northeastern Brazil, is reported here for the first time. They have been found in twelve sites extending throughout 2,900 km² of the middle São Francisco river fossil dunefield (Fig. 1). The sands have been submitted, at first stage, to sieving to concentrate charcoal fragments, which have been finally sampled by hand-picking. Charcoal fragments were found between 50 to 150 cm of depth, but were mostly concentrated from 60 to 90 cm.

The eolian sands with charcoal fragments, exhibiting apparently massive structure, were found in frequent association with recent plant roots. We have used larger sampling intervals whenever the charcoal particles were more scarce in the samples. The small sized charcoal fragments and their distri-

bution pattern suggest that they have been transported mostly by winds.

SIGNIFICANCE OF CHARCOAL IN HOLOCENE DEPOSITS

Episodes of Holocene climatic disturbances with forest fires, are likely to be a consequence of the interaction between periods of drier climates and human occupation. It is well known that archaeological sites became abundant in the tropical part of Brazil after 5,000 years BP, along the coastal as well as in the interior areas. However, the evidence of middle Holocene forest fires provided by charcoal fragments, is not exclusive of places previously occupied by humans, since carbonized particles have also been reported to occur in soils developed under several types of primary forest (Sanford *et al.*, 1985).

Although one cannot completely discard an anthropogenic origin for the occurrence of charcoal particles in the studied site, the coincidence of their ¹⁴C ages (Tab. I) with drier climates suggested by several authors in many areas of Brazil is impressive (Fig. 2).

The oldest ¹⁴C date for the charcoal fragments from the middle São Francisco River fossil dune-

TABLE I
Radiocarbon dates from twelve charcoal samples from the middle São Francisco River fossil dunefield (¹⁴C dating by CENA/USP).

Sample	Laboratory number	Age number	Level (cm)	Age (years BP)
C1	419	CENA-150	50-65	1,700±60
C2	425	CENA-154	50-80	1,410±60
C3	428	CENA-155	50-70	1,600±80
C4	429	CENA-156	50-70	1,250±60
C5	421	CENA-151	50-80	1,570±60
C6	431	CENA-157	50-70	850±60
C7	415	CENA-148	90-120	3,310±70
C8	423	CENA-152	50-80	950±60
C9	432	CENA-158	50-80	1,360±70
C10	424	CENA-153	50-80	870±60
C11	430	CENA-159	50-70	1,220±60
C12	418	CENA-149	90-150	4,860±70

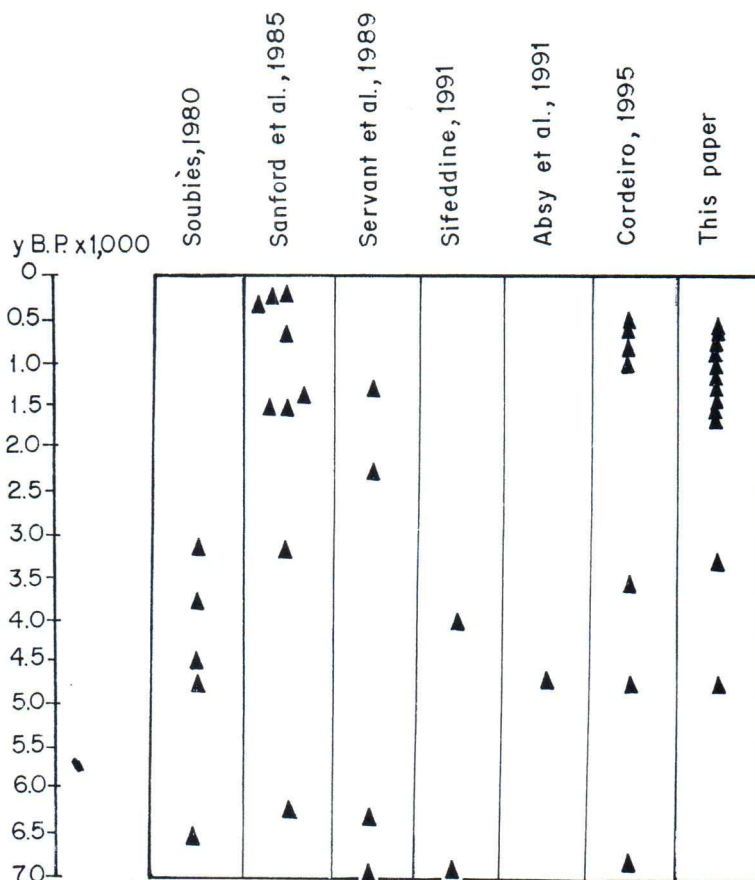


Fig. 2 — Correlation of radiocarbon ages obtained from charcoal samples studied by several authors in Brazil.

field is $4,860 \pm 70$ years BP, which can be easily correlated with those from Santarém-Cuiabá road (Soubies, 1980), lacustrine deposits in northern Serra dos Carajás, in eastern Brazilian Amazonia (Absy *et al.*, 1991; Cordeiro, 1995).

The radiocarbon age of $3,310 \pm 70$ years BP falls within the age range of charcoal particles dated at 3,105 years BP (Soubies, 1980), 3,080 years BP (Sanford *et al.*, 1985) in soils, and 3,500 years BP in Amazonian lake sediments (Cordeiro, 1995).

The remaining radiocarbon ages presented in Table I fall between 1,700 and 850 years BP, thus suggesting the widespread occurrence of vegetation fires during this period.

All reports, mentioned above, describing the presence of charcoal particles either in soils or lake sediments, have been conducted in regions charac-

terized by very humid climate and possessing tropical rainforest vegetation, which do not correspond to the prevailing climate and vegetation of our studied site. In addition to a semi-arid climate and a caatinga vegetation cover, our studied site is strongly sensitive to drying conditions which could lead it to an arid condition given a certain reduction in precipitation level. Nevertheless, the synchrony of age ranges of charcoal particles in different regions suggests that some Holocene climatic periods were characterized by important continental scale vegetation fires (Fig. 3).

CONCLUSIONS

Based on the assumption that the charcoal fragments from the São Francisco River fossil dunefield have been originated from the arboreal caatinga-type vegetation, perhaps related to pio-

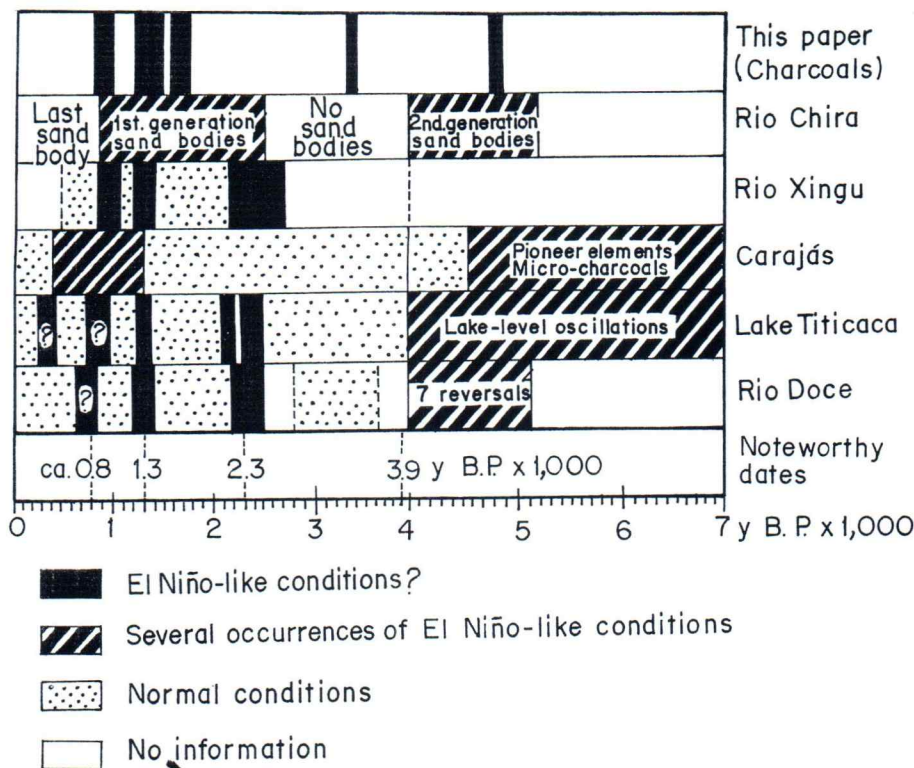


Fig. 3 — Teleconnection of El Niño-like conditions identified in several parts of South America, and the radiocarbon ages of charcoal particles dated in this study.

neer species developed during short intervals of climatic amelioration, and that the obtained radiocarbon ages represent averages for several charcoal-bearing intervals, it is possible to conclude that:

a) Before 4,800 years BP the climate of the studied area was probably drier than today and characterized by few occurrences of vegetation fires;

b) From 1,700 to 850 years BP there was a strong tendency for the occurrence of vegetation fires;

c) The present caatinga-type vegetation was probably stabilized only after 850 years BP, in the studied area, because the youngest charcoals provided this age.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Paulo Eduardo de Oliveira for careful revision of the text.

REFERENCES

- ABSY, M. L.; VAN DER HAMMEN, T.; SOUBIES, F.; SUGUIO, K.; MARTIN, L.; FOURNIER, M. & TURCQ, B., (1989), *Data on the history of vegetation and climate in Carajás, Eastern Amazonia*. International Symposium on Global Changes in South America during the Quaternary. Special Publication no. 1: 99-105.
- ABSY, M. L.; CLEEF, A.; FOURNIER, M.; MARTIN, L.; SERVANT, M.; SIFEDDINE, A.; SILVA, M. F. DA; SOUBIES, F.; SUGUIO, K.; TURCQ, B. & VAN DER HAMMEN, T., (1991), Mise en évidence de quatre phases d'ouverture de la forêt dense dans le sud-est de l'Amazonie au cours des 60.000 dernières années. Première comparaison avec d'autres régions tropicales. *C.R. Acad. Sci. Paris*, t. 312, Série II, p. 673-678.
- BARBERI-RIBEIRO, M., (1994), *Paleovegetação e paleoclima no Quaternário tardio da vereda de Águas Emendadas, D. F. Brasília*, 110p. (Dissertação de Mestrado, Univ. de Brasília).

- BARRETO, A. M. F. & SUGUIO, K., (1992), *Morfologia das paleodunas do médio rio São Francisco e os paleoventos*. 37º Congresso Brasileiro de Geologia. Boletim de Resumos Expandidos: 301-302.
- CORDEIRO, R. C., (1995), *Mudanças paleoambientais e ocorrência de incêndios nos últimos 7.400 anos na região de Carajás, Pará*. Niterói, 115 p. (Dissertação de Mestrado, Univ. Fed. Fluminense).
- SANFORD, R. L.; SILDARRIAGA, J.; CLARK, K. E.; UHL, C. & HERRERA, R., (1985), Amazon rainforest fires. *Science*, **227**: 53-55.
- SCHEEL, R.; VERNET, J. L.; WENGLER, L. & FOURNIER, M., (1995), *Carvões do solo em São Pedro, Estado de São Paulo, Brasil: datação, notas sobre o paleoambiente no Quaternário recente, condições do depósito, origem do fogo e proposta de estudos antracológicos*. Anais do V Congresso da ABEQUA: 169-175.
- SERVANT, M.; FOURNIER, M.; SOUBIES, F.; SUGUIO, K. & TURCO, B., (1989), Sécheresse holocène au Brésil (18-20° latitude sud). Implications peléométéorologiques. *C.R. Acad. Sci. Paris*, t. **309**, Série II: 153-156.
- SOUBIES, F., (1980), Existence d'une phase sèche en Amazonie brésilienne datée par la présence de charbons de bois (6000-3000 ans BP). *Cah. ORSTOM, Sér. Géol.*, **1**: 133-148.
- THOMAS, D. S. G. & SHAW, P. A., (1991), Relict desert dune systems: interpretations and problems. *Journal of Arid Environments*, **20**: 1-14.
- VERNET, J. L.; WENGLER, L.; SOLARI, M. E.; CECCANTINI, G.; FOURNIER, M.; LEDRU, M. P.; SOUBIES, F., (1994), Feux, climats et végétations au Brésil central durant l'Holocène: les données d'un profil de sol à charbons de bois (Salitre, Minas Gerais). *C.R. Acad. Sci. Paris*, t. **319**, Série II: 1391-1397.